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TRAINING WITH MINE-RESCUE BREATHING APPARATUS

BY

JAMES W. PAUL

WASHINGTON
GOVERNMENT PRINTING OFFICE
1912

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TRAINING WITH MINE-RESCUE BREATHING APPARATUS.

By JAMES W. PAUL.

INTRODUCTION.

The Bureau of Mines, in its endeavor to aid in decreasing loss of life and property in mining operations, is demonstrating the use of mine-rescue breathing apparatus and is training miners to use such apparatus under the conditions following a mine disaster. In a previous publication of the bureau, Miners' Circular 4, "The Use and Care of Mine-Rescue Breathing Apparatus," the author of this report discussed the construction of different types of breathing apparatus, the precautions to be observed in using such apparatus, and the general course of training recommended by the bureau.[a] Because of the great interest that has been taken in the work of mine-rescue and first-aid corps and in the establishment of mine-rescue stations, the bureau is issuing this report in order to present in detail the methods of training that it recommends, and to point out the necessity of maintaining the efficiency of mine-rescue corps by frequent training.

Systematic training is essential to insure the safe use of any type of breathing apparatus. The quantity and the quality of the air supplied by some types of these apparatus have certain limitations, and the wearer of an apparatus must be familiar with its construction and its operation before he undertakes to wear it under the conditions of rescue and recovery work in mines.

There is some difference of opinion among persons who have worn breathing apparatus in actual mine-rescue work as to the length of time a man should be required to receive training with the apparatus before he is to be considered as qualified to engage in mine-rescue or recovery work. All, however, admit that it is necessary for a man to take regular training at stated intervals in order to keep in proper condition for wearing the apparatus in cases of emergency. Whether the duration of the intervals be two weeks or three months,

[a] Paul, J. W., The use and care of mine-rescue breathing apparatus: Miners' Circular 4, Bureau of Mines, 1911, 24 pp.

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some system of regular practice should be adopted. The Bureau of Mines requires each of the miners it employs at its mine-safety cars and stations to take two hours' practice in vitiated air once each week.

At mining camps or mines where rescue stations are established, the regular mine-rescue corps should be required, after completing their preliminary training, to undergo practice at frequent intervals. In localities where rescue stations and apparatus are not available, it is of course impracticable for persons who have received preparatory training to keep up regular practice. Such persons, however, are very valuable in time of a disastrous explosion, since their training and instruction in the use of the apparatus enables them to be of great assistance to a crew of rescuers who may arrive with breathing apparatus.

The author can attest to most efficient service having been rendered by miners who had received the training and instruction outlined in the course given by the Bureau of Mines.

The purpose of this course of instruction and training is to familiarize miners with the construction, principles of operation, manner of charging, and proper care of the apparatus, and its use in gases that are not breathable, in order that these miners may be available for service in time of mine explosions or fires to cooperate or assist in rescue operations. The bureau recommends, however, that persons who have taken the course of training should supplement it by regular practice, lasting two hours, at least once every three months, and more frequently, say once each week, if they belong to an organized rescue crew attached to a station.

THE BUREAU'S SCHEDULE OF TRAINING.[a]

Until conditions warrant, or a further study into the subject of training justifies a revision of the schedule, the following outline will be followed by the instructors of the bureau:

PHYSICIAN'S EXAMINATION.

A person presenting himself for training is requested to present a written statement from a physician to the effect that he has been examined and is in condition to undergo mine-rescue training. In the absence of such a statement from a physician, the applicant is started in the course of training, and if he completes the requirements without undue fatigue as evidenced by his pulse, respiration, and general appearance, he is certified as being entitled to a certificate setting forth the work that he accomplished. If in the course of the training he shows evidence of being unsuited for mine-rescue work, he is so advised and his training ceases.

[a] Revised Oct. 1, 1912.

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SUPPLIES.

The course of training in the use of breathing apparatus for mine-rescue work as outlined contemplates the use of the following list of supplies:

Schedules "B" and "C"	1 regenerator charge. 2½ hours' supply of oxygen.
Schedule "D"	1 regenerator charge. 2 hours' supply of oxygen.
Schedule "E"	1 regenerator charge. 2 hours' supply of oxygen.
Schedule "F"	1 regenerator charge. 2 hours' supply of oxygen.
Summary	4 regenerator charges. 8½ hours' supply of oxygen, approximately 45 cubic feet.

The regenerator charge used in Schedule "B" may also be used for Schedule "C" without apparent discomfort to the wearer of the apparatus.

Upon completing each schedule, the person being trained shall clean his apparatus and put it in order for emergency use.

OUTLINE OF COURSE.

FIRST DAY.

Instruction in construction of breathing apparatus, wearing apparatus one hour without oxygen, and performing work as per Schedule "A."

SECOND DAY.

Instruction on pump and charging and care of apparatus, wearing apparatus one hour with oxygen in fumes, and performing work as per Schedule "B."

THIRD DAY.

Instructions in testing and repair of apparatus and pump, wearing apparatus one and one-half hours in fumes and smoke, and performing work as per Schedule "C."

FOURTH DAY.

Wearing apparatus two hours in fumes and smoke, performing work as per Schedule "D," and instruction in construction and use of reviving devices.

FIFTH DAY.

Wearing apparatus two hours in a mine, as per Schedule "E," and rescue organization.

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SIXTH DAY.

Rescue organization, rescue work, etc., and wearing apparatus two hours in mine as per Schedule "F."

SCHEDULE "A"—WITHOUT OXYGEN BEING USED.

1. Make 12 circuits about smoke room (or car). Go over steps and platform on demonstration end of car in lieu of an overcast.
2. Operate weight machine 50 times or lift 40-pound sand bag to a height of 4 feet 25 times.
3. Walk a distance of about 1 mile.
4. Remove and replace oxygen bottle and regenerating cartridge while apparatus is on the back, if using Draeger 1910 apparatus.[a]
5. Crawl a distance of 36 feet.
6. Remove and replace oxygen bottle and regenerating cartridge while kneeling, if using Draeger 1910 apparatus.[a]
7. Make circuits about smoke room (or car) until hour is consumed.

SCHEDULE "B"—WITH OXYGEN, IN FUMES.

Duplicate Schedule "A," but work should be performed in fumes, if possible. In case no smoke room or gallery is available, the work may be performed in the open air, or within a mine.

SCHEDULE "C"—WITH OXYGEN, IN FUMES AND SMOKE.

1. Walk 10 laps in smoke room (or in car).
2. Carry three props over overcast or an obstruction and wedge them up under a collar.
3. Carry brattice cloth over overcast or an obstruction and stretch it up at a place designated.
4. Load 10 bricks in a gunny sack and carry over overcast or an obstruction; return and deposit where found.
5. Saw two pieces off a prop.
6. Remove and replace oxygen bottle and regenerating cartridge with apparatus on back, if using Draeger 1910 apparatus. (See note under Schedule "A," 4.)
7. Take down brattice and return to point where originally found.
8. Carry dummy (150 pounds), in arms or on back (one man), over overcast or an obstruction and leave at point found.
9. Remove and replace oxygen bottle and regenerating cartridge while kneeling, if using Draeger 1910 apparatus. (See note under Schedule "A," 4.)

[a] It is not recommended that this be done by the person wearing the apparatus in actual mine-rescue or recovery work, except in extreme emergency.

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10. Take down props and return to point where originally found.
11. Crawl 40 feet through tunnel.
12. Alternately pull weight machine 50 times, or lift sand bag 25 times, and make circuits around room until hour and a half is completed. (The weight to be pulled or lifted shall be 40 pounds, and the height raised shall be noted in records.)

SCHEDULE "D"—WITH OXYGEN, TWO HOURS IN FUMES AND SMOKE.

1. Walk 20 laps in room (or car).
2. Carry six props over overcast or an obstruction and wedge up under a collar.
3. Carry brattice cloth over overcast or an obstruction and hang up at a place designated.
4. Remove and replace oxygen bottle and regenerating cartridge while kneeling, if using Draeger 1910 apparatus. (See note under Schedule "A," 4.)
5. Carry a dummy, on stretcher, over overcast or an obstruction and leave at place found.
6. Carry 150 bricks, in lots of 10, in gunny sack over overcast or an obstruction and build a dry wall.
7. Take down props and brattice cloth and return to places where originally found.
8. Remove and replace oxygen bottle and regenerating cartridge with apparatus on back, if using Draeger 1910 apparatus. (See note under Schedule "A," 4.)
9. Crawl through tunnel four times. This tunnel may be constructed of boards, which can be found at almost any mine. Dimensions to be: 19 inches high, 17 inches wide, and 16 feet long.
10. Lay and connect four pieces of 2-inch pipe.
11. Pull weight machine 50 times, or lift sand bag 25 times.
12. Disconnect pipe and return to place where originally found.
13. Alternately walk 5 laps in a room and crawl once through a tunnel until two hours are completed.

SCHEDULE "E"—MINE WORK, TWO HOURS WITH OXYGEN.

Load coal into car, carry props, drag rails, stack ties, put up timber, or chop ends off props.

If impracticable to enter mine, the miner should shovel ashes, drag rails or timber, or wheel brick, stone, or coal (100 pounds) a distance of 600 feet, and perform such additional labor as will be equal to that stated in the preceding paragraph.

SCHEDULE "F"—MINE WORK, TWO HOURS WITH OXYGEN.

Immediately upon arriving at the entrance to mine have squads organized exactly as would be done in case the corps were responding to an emergency call. As soon as the point has been reached that

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has been chosen as the base of operations, the first squad should test out the apparatus thoroughly. These tests should consist of the water-gage and liter-bag readings, and the circulation test to detect leaks. All connections should be examined and tightened, especially the tube connections and cap on the bottom of the Draeger cooler. The second squad should get brattice, air-lock doors, and a life line in readiness for entrance of first squad to the danger zone, and arrange for relieving the first squad when necessary. Several men who are supposed to have received injuries, or are unconscious as a result of an explosion, should be rescued. These "victims" should be taken, on a stretcher, over falls and cars, and through trapdoors and air locks, and the bearers should carry the stretcher for, say 100 feet, while crawling on hands and knees. Similar conditions are often met in mine disasters and considerable practice is desirable. The life line should be utilized in the mine practice, with a prearranged code of signals which should be in writing and furnished each member of the crew.

COOPERATIVE TRAINING.

At a number of mines and schools of mines in the United States breathing apparatus is used for training purposes. For the purpose of cooperating with these and with a view of extending the list of available miners who might be of service to the bureau at times of disasters, opportunity has been made whereby certain training stations may be listed on the cooperative basis, and provision made for the issuance of training certificates to persons who may have taken training. The plan of cooperation was announced in a circular issued by the director, Dr. Holmes, under date of April 29, 1911, which reads:

In the investigative work of this bureau it becomes necessary at times to employ temporarily miners who have been trained in the use of breathing apparatus. It is the desire to procure for such service miners whose training renders them most efficient.

To extend the list of available miners trained in the use of breathing apparatus by this bureau, it is proposed to conduct supplemental training of miners trained at private or State stations and to issue rescue-training certificates to all who prove themselves eligible.

In this cooperative work the bureau will follow the scheme outlined below:

1. Representatives of the bureau, upon invitation, will inquire into the facilities provided by mine owners, States, or organizations for furnishing instruction and training in the use of breathing apparatus; and such stations as appear adequately equipped will be recorded as cooperating training stations.

2. Men training in the use of breathing apparatus at such stations will, upon application, be invited to appear at Government rescue stations or cars for examination for the receipt of a Bureau of Mines certificate of training; or will be examined by Government engineers or foremen at private stations when such procedure is practicable.

3. Those persons who pass the examination will be certified to this bureau for record and the issuance of a certificate. Applications for record as cooperating training stations, or for supplemental training for a Bureau of Mines certificate, should be made to the Bureau of Mines, Pittsburgh, Pa.

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To meet the provision of the above announcement in dealing with applications for listing as cooperative stations a form was prepared which called for detailed information as to the facilities and equipment at such stations. It reads as follows:

UNITED STATES BUREAU OF MINES COOPERATIVE-TRAINING STATION.

At..... Established....., 19...
Operated by.....
(Name of company or institution.)
Name of foreman.....
Foreman holds Bureau of Mines certificate No.....dated.....
Number of assistants..... Number of rescue or training cars operating in connection, with brief description of equipment.....
.....
How many rescue apparatus employed..... Make and type of apparatus
.....
Remarks: .....
.....

Instructions were issued for the guidance of the foreman of stations and cars of the bureau in passing upon applications for training certificates by persons who had received training at stations other than those under the direction of the bureau. These instructions with form of application follow:

CREDIT FOR WORK DONE WITH BREATHING APPARATUS.

To apply in issuing certificates of mine-rescue training by the Bureau of Mines.

Persons who have received instruction and training in the use of breathing apparatus at a station not conducted by the Bureau of Mines will be given certain credits in the issuance of certificates of mine-rescue training as follows:

1. The foreman of the station or car will have each candidate submit a statement of the training and instruction he has received, giving the name of the station and person under whom he received his training, and the number of hours the apparatus was worn in smoke or fumes, which statement shall be certified by the official who conducted the training work.

2. The applicant will be questioned concerning the construction, charging, care, and proper use of the apparatus.

3. The applicant will be required to recharge the apparatus, put it on, and show his familiarity with it.

4. The applicant will be required to conduct tests of the apparatus to determine the pressure and vacuum in the tube and the volume of oxygen passing through the reducing valve.

5. In the presence of the foreman, the applicant will be required to wear a breathing apparatus in smoke or fumes for two hours while performing a schedule of work, such as carrying props, brick, or sand, sawing props, etc. This training may be conducted at the private station where the applicant received his training or at a station or car of the Bureau of Mines.

6. Before recommending the applicant for a certificate of mine-rescue training, he should have at least 10 hours' training in wearing the apparatus, and should have worn the apparatus in unbreathable air for at least two periods of two hours each.

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APPLICATION FOR CERTIFICATE OF MINE-RESCUE TRAINING.

I hereby make application for a certificate of mine-rescue training issued by the Bureau of Mines, and submit below a record of the instruction, training, and experience I have received.

Name..... Address..... Occupation.....
Employed by..... Age..... Nationality.....
Name of training station..... Location.....
Operated by..... Type of apparatus used.....
Nature of atmosphere in which training was given.....
Total number of hours apparatus was worn in smoke or fumes.....
Number of times apparatus was worn in smoke or fumes for the full period of two hours.....
Approximate dates or times at which above training was received.....
.....
Experience of applicant in wearing the apparatus in mines after explosions or during mine fires (give dates and names of mines):
.....
.....
.....

.....
(Signature of applicant.)

I hereby certify that I am in charge of the instruction and training work at the station named, and that the above statements are true.

.....

....., 191...

On the....day of....., 191.., I examined the above applicant in accordance with the schedule of "Credit for work done with breathing apparatus," and found that he had.....been duly informed concerning the use of the apparatus.

I gave him instructions and training work at.....as outlined on the attached schedule of training work, and I recommend that he be given a certificate of mine-rescue training.

....., *Foreman.*

Station or car.....

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RECORD OF TRAINING.

The form used for recording the training work performed by each person is shown below. This is filled out in duplicate, one copy for retention as a record of the training station, the other for the files of the engineer in charge of training.

Mine-rescue training record.

1. Car No. ..... } at ..... Miner's name ..... No ....
   Station No. ..... }
2. Address ..... Occupation .....
3. Employer .....
4. Chest: Normal ..... Contracted ..... Expanded ..... Expansion .....
5. Age ..... Weight ..... Height ..... Where born .....
6. How long in U. S..... Can he read and speak English ..... Married .....
7. How long has he been engaged in mining ..... Coal or metal mines .....
8. Pulse and respiration: While standing P ... R ...; after hopping 20 ft. P ... R ...
9. Date on which apparatus was explained ..... Time occupied .....
10. Date on which miner charged and set up apparatus ..... Time occupied .....
11. Type of apparatus used in training ..... Number ....

12. Month in which training was given.....								
13. Dates on which training was given.....								
14. Schedule of training used.....								
15. Time occupied in wearing apparatus.....								
16. Trained in SO_2, smoke, or fresh air, gases and kind.....								
17. Trained in car, smoke room, or elsewhere...								
18. Temperature of air.....								
19. Distance walked (miles or fractions).....								
20. Distance crawled (feet).....								
21. Number of trips over overcast or obstruction.....								
22. Height ascended (feet).....								
23. ....pounds of ..... carried (feet).								
24. ....pounds {Work machine operated / Sand bag lifted .... ft.} times.								
25. Size of prop used.....								
26. Sawed end off how many props.....								
27. Number of timbers set up.....								
28. Pulse just before taking off apparatus.....								
29. Oxygen remaining when taken off.....								
30. Dizzy (1), tired (2), exhausted (3), headache (4).....								
30A. Other work performed.....								
31. Percentage.....								

32. Total time wearing the apparatus..... Hours ..... Minutes
33. Has the miner full confidence in the apparatus..... .....
34. Would he make a good mine-rescue man..... .....
35. Is he entitled to a certificate..... .....
36. Rating..... .....

Date ..... 19.. .....,

Foreman.

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Daily record of training.

For convenience in recording the work done by a squad of men at a station or car the following form has been devised:

Daily record of training given at.....safety station..... car No.....
Cooperative or private station....., with breathing apparatus (a record to be made of each person wearing the apparatus).
Year 19.., month....., day..... Temperature outside..... Time.....
Hours during which training was given.....; regenerators used.....; cubic feet oxygen used, ...; caustic soda used.....

Number assigned to person trained.....														
10. Time occupied charging and testing his apparatus.....														
11. Name of apparatus used.....														
11A. Type of helmet, mouth or face mask..														
11B. Number of the apparatus.....														
11C. Minutes of oxygen in apparatus at start.....														
14. Schedule of training used.....														
15. Time occupied wearing apparatus.....														
16. Trained in SO_2, smoke, fresh air, gas..														
17. Trained in car, smoke room, or elsewhere.....														
18. Temperature of air.....														
19. Distance walked (miles or fractions)...														
20. Distance crawled (feet).....														
21. Number of trips over overcast.....														
22. Height ascended (feet).....														
23. .....pounds of.....carried.(feet)..														
24. } 24A. } ....pounds { Work machine operated. / Sand bag lifted, feet. } times..														
25. Size of prop used.....														
26. Sawed end off how many props.....														
27. Number of timbers set up.....														
27A. Bushels of.....loaded.....														
27B. Distance traveled underground.....														
28. Pulse just before taking off apparatus..														
28A. Respiration just before taking off apparatus.....														
29. Oxygen remaining when taken off, minutes.....														
30. Dizzy (1), tired (2), exhausted (3), headache (4).....														
31. Percentage.....														

The above entries were made by....., title..... date.....
The above record was transferred to training reports by.....; title .....; date.....
Date and initials of officials authorized to inspect this report.....

RATING.

To be eligible for the issuance of a certificate the person trained is required to make an average of 80 per cent.

METHOD OF RATING.

Each day's work is rated upon the degree of efficiency with which it may be accomplished, and on line 31 the percentage, based upon 100, is entered. Each day's work is given definite weights, which are used in arriving at the average rating in line 36. The weights are as follows: First day, 5; second day, 10; third day, 15; fourth day, 20; fifth day, 25; sixth day, 25; total, 100.

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These weights are multiplied by the percentages as shown on line 31, respectively, the average rating being the sum of the several products.

To facilitate the rapid calculation of the rating the following table has been prepared between 70 and 100 per cent.

Table of percentages.

[Weights and ratings.]

100.....	5.00	10.00	15.00	20.00	25.00	25.00
99.....	4.95	9.90	14.85	19.80	24.75	24.75
98.....	4.90	9.80	14.70	19.60	24.50	24.50
97.....	4.85	9.70	14.55	19.40	24.25	24.25
96.....	4.80	9.60	14.40	19.20	24.00	24.00
95.....	4.75	9.50	14.25	19.00	23.75	23.75
94.....	4.70	9.40	14.10	18.80	23.50	23.50
93.....	4.65	9.30	13.95	18.60	23.25	23.25
92.....	4.60	9.20	13.80	18.40	23.00	23.00
91.....	4.55	9.10	13.65	18.20	22.75	22.75
90.....	4.50	9.00	13.50	18.00	22.50	22.50
89.....	4.45	8.90	13.35	17.80	22.25	22.25
88.....	4.40	8.80	13.20	17.60	22.00	22.00
87.....	4.35	8.70	13.05	17.40	21.75	21.75
86.....	4.30	8.60	12.90	17.20	21.50	21.50
85.....	4.25	8.50	12.75	17.00	21.25	21.25
84.....	4.20	8.40	12.60	16.80	21.00	21.00
83.....	4.15	8.30	12.45	16.60	20.75	20.75
82.....	4.10	8.20	12.30	16.40	20.50	20.50
81.....	4.05	8.10	12.15	16.20	20.25	20.25
80.....	4.00	8.00	12.00	16.00	20.00	20.00
79.....	3.95	7.90	11.85	15.80	19.75	19.75
78.....	3.90	7.80	11.70	15.60	19.50	19.50
77.....	3.85	7.70	11.55	15.40	19.25	19.25
76.....	3.80	7.60	11.40	15.20	19.00	19.00
75.....	3.75	7.50	11.25	15.00	18.75	18.75
74.....	3.70	7.40	11.10	14.80	18.50	18.50
73.....	3.65	7.30	10.95	14.60	18.25	18.25
72.....	3.60	7.20	10.80	14.40	18.00	18.00
71.....	3.55	7.10	10.65	14.20	17.75	17.75
70.....	3.50	7.00	10.50	14.00	17.50	17.50

PUBLICATIONS ON MINE ACCIDENTS AND EXPLOSIVES.

The following Bureau of Mines publications may be obtained free by applying to the Director, Bureau of Mines, Washington, D. C.:

BULLETIN 10. The use of permissible explosives, by J. J. Rutledge and Clarence Hall. 1912. 34 pp., 5 pls.

BULLETIN 15. Investigations of explosives used in coal mines, by Clarence Hall, W. O. Snelling, and S. P. Howell, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe. 1911. 197 pp., 7 pls.

BULLETIN 17. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 10 pls. Reprint of United States Geological Survey Bulletin 423.

BULLETIN 20. The explosibility of coal dust, by G. S. Rice, with chapters by J. C. W. Frazer, Axel Larsen, Frank Haas, and Carl Scholz. 204 pp., 14 pls. Reprint of United States Geological Survey Bulletin 425.

BULLETIN 44. First national mine-safety demonstration, by H. M. Wilson and A. H. Fay, with a chapter on the explosion at the experimental mine, by G. S. Rice. 1912. 75 pp., 7 pls.

BULLETIN 46. An investigation of explosion-proof mine motors, by H. H. Clark. 1912. 44 pp., 6 pls.

TECHNICAL PAPER 4. The electrical section of the Bureau of Mines, its purpose and equipment, by H. H. Clark. 1911. 12 pp.

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